

**What is claimed is:**

- 1 1. A method for focused ion beam (FIB) gas-assisted etching (GAE) of an integrated  
2 circuit die, the method comprising:  
3 supplying etch gas, including a halide gas, to the die;  
4 etching a selected portion of the die using the etch gas and an ion beam directed at  
5 the selected portion; and  
6 while etching the die, supplying sufficient oxygen-containing gas to the die to  
7 inhibit corrosion of a portion of the copper in the die being exposed to the etch gas.
- 1 2. The method of claim 1, wherein etching the die includes using a vacuum chamber.
- 1 3. The method of claim 2, wherein supplying sufficient oxygen-containing gas  
2 includes opening an oxygen-containing gas valve to an oxygen-containing gas supply  
3 outlet in the vacuum chamber and maintaining a selected pressure in the chamber.
- 1 4. The method of claim 3, prior to etching the die, further comprising etching a test  
2 die in the chamber, the test die having similar copper structure to the die to be etched, and  
3 determining therefrom a selected pressure to maintain via the oxygen-containing gas  
4 supply that prohibits corrosion of the copper.
- 1 5. The method of claim 3, wherein the pressure in the chamber is maintained between  
2 about  $5.0\text{e-}6$  and  $1.0\text{e-}5$  Torr.

1 6. The method of claim 3, further comprising attaching a nozzle to the oxygen-  
2 containing gas supply outlet, the nozzle being adapted to direct oxygen-containing gas to a  
3 selected portion of the die during etching.

1 7. The method of claim 1, wherein supplying the etch gas includes supplying  
2 sufficient oxygen to the die to inhibit corrosion of a portion of the copper in the die being  
3 exposed to the etch gas.

1 8. The method of claim 1, wherein the halide gas includes at least one of: chlorine,  
2 bromine and iodine.

1 9. The method of claim 1, wherein the die includes a flip-chip type die having  
2 circuitry in a circuit side opposite a back side, and wherein etching the die includes at least  
3 one of: etching the die from the circuit side and etching the die from the back side.

1 10. The method of claim 1, wherein supplying sufficient oxygen-containing gas  
2 includes using oxygen as a gettering agent.

1 11. The method of claim 1, further comprising detecting a level of halide in the  
2 chamber prior to etching the die with an ion beam, wherein etching the die includes etching  
3 in response to the detected halide level being below a threshold level defined as a function  
4 of the die, the etching and the supplying of oxygen-containing gas.

1 12. The method of claim 1, further comprising detecting a level of halide in the  
2 chamber prior to supplying sufficient oxygen-containing gas to the die, wherein supplying  
3 sufficient oxygen-containing gas includes supplying an amount of oxygen in response to  
4 the detected halide level.

1 13. The method of claim 11, wherein the threshold level of halide is selected such that  
2 levels of halide below the threshold level produce an amount of corrosion with copper in  
3 the die that is below an acceptable design amount.

1 14. The method of claim 1, wherein supplying sufficient oxygen-based gas includes  
2 supplying a gas selected from the group of: oxygen, nitrous-oxide and ozone.

1 15. A system for focused ion beam (FIB) gas-assisted etching (GAE) of an integrated  
2 circuit die comprising copper, the system comprising:

3 means for supplying etch gas, including a halide gas, to the die;

4 means for supplying oxygen-containing gas to the die, the oxygen-containing gas  
5 supply being sufficient to inhibit corrosion of a portion of the copper in the die being  
6 exposed to the etch gas; and

7 means for etching a selected portion of the die using the etch gas and an ion beam  
8 directed at the die.

1 16. A system for focused ion beam (FIB) gas-assisted etching (GAE) of an integrated  
2 circuit die comprising copper, the system comprising:

3 an etch gas supply adapted to supply etch gas, including a halide gas, to the die;  
4 an oxygen-containing gas supply adapted to supply oxygen-containing gas to the  
5 die, the oxygen-containing gas supply being sufficient to inhibit corrosion of a portion of  
6 the copper in the die being exposed to the etch gas; and  
7 an etch device adapted to etch a selected portion of the die using the etch gas and a  
8 FIB directed at the die.

1 17. The system of claim 16, further comprising a vacuum chamber adapted to enclose  
2 the die for etching.

1 18. The system of claim 17, wherein the etch device is adapted to etch aluminum using  
2 the halide and the ion beam.

1 19. The system of claim 17, further comprising a detector located in the vacuum  
2 chamber and adapted to detect a level of halide in the chamber.

1 20. The system of claim 19, further comprising a controller coupled to the detector and  
2 adapted to control the etch device in response to a halide level detected by the detector.

1 21. The system of claim 20, wherein the controller is further adapted to control the  
2 oxygen-containing gas supply in response to a halide level detected by the detector.